AFRP 50-3, Volume XXIX, Number 3, Winter 1982

THE NAVIGATOR

Project Warrior

NAV OF NOTE

LIEUTENANT COLONEL RONALD L. MOREY

Lieutenant Colonel Ronald L. Morey is the Commander of the 16th Tactical Airlift Training Squadron, Little Rock AFB, Arkansas. The largest C-130 squadron in the Military Airlift Command, the 16th is responsible for initial qualification training for all C-130 crew positions for the Air Force, Navy, Marines, Coast Guard, and over 20 foreign nations.

Colonel Morey is a 1966 graduate of the Air Force Academy. After completing UNT at Mather AFB, as a distinguished graduate, his first operational assignment was in the C-130 at Ching Chuan Kang AB, Taiwan, where he upgraded to instructor navigator. Reflecting on that first assignment, Col Morey said, "My goal, and really the goal for any officer, was and still is to be the best at my job in my unit. Also I learned a lot about the airplane and the mission from other crew members. That knowledge has helped me immensely during my career. I have seen far too many navigators fall into what I call the 'I'm just a nav' syndrome. You simply can't afford to be 'just a nav.' You must strive to make yourself as knowledgeable as possible about your aircraft, its systems, and the operational environment. Also, you should understand all the support elements of a squadron or wing."

After CCK, Colonel Morey moved to Forbes AFB, where he upgraded to Flight Examiner in the 313th Tactical Airlift Wing. In 1973, he was assigned to the Pentagon under the Air Staff Training Program (ASTRA) and, following his ASTRA tour, he stayed at the Pentagon to serve as a policy and projects officer and as Chief of the Congressional Liaison Branch of the Air Force Academy Activities Group, DCS/Personnel, until 1978. He next attended Armed Forces Staff College, followed by a return to C-130s at McChord AFB, Washington.

"Returning to McChord, I looked forward to flying with enthusiasm. Again, I strived to be the best navigator in the unit and I also sought other challenges. In my varied assignments, I have learned that you must make the best possible use of operational and flying training hours. Only by maintaining a keen edge will you be confident that you can hack it when you're asked to lead the squadron in its ORI or into battle, should that ever be called for. Also, it's important to broaden your horizons through additional duties and special projects whenever possible. These can give you valuable experience in areas other than your primary duty and can prepare you for unusual situations that may arise. You gain the confidence and trust of your supervisors because they know you can tackle any job you're given. One of the most important things I have come to realize is that one should cultivate every opportunity to learn to write and speak effectively. The people I have worked for, who have moved up to excellent jobs, invariably have been good, solid writers and could speak clearly and concisely. I know that my writing ability was one of the primary reasons I stayed in the Pentagon and was selected to be the DO's exec at McChord. Those jobs certainly were boosts to my career."

In 1980, Col Morey moved to Little Rock AFB and first served as the Navigator Resource Manager of the 62d Tactical Airlift Squadron. He later became the Assistant Director of Operations, 34th Tactical Airlift Training Group, and was serving in that job when selected to command the 16th.

Col Morey has positive views on command. "As the Commander, I accept responsibility for the entire unit, and I totally back my aircraft commanders and operations staff. I am very fortunate to have a wealth of talented people in this squadron. Learning to use them most effectively is one of my greatest challenges. I'm excited about this chance to lead MAC's largest flying squadron. We fly over 18,000 hours per year and have the equivalent of 28 assigned aircraft—far above the norm for a typical MAC unit. My squadron is selectively manned with the experts in the C-130 business. My goal is to make sure all that expertise and all those flying hours produce the best possible product, and do it safely. I would like to think that we can imbue the 'trash hauling spirit' in each of our graduates. For you readers who have never been assigned to tactical airlift, what I mean by 'trash hauling spirit' can be summed up simply: 'Work hard, play hard, and somehow find a way to hack a tough mission despite seemingly insurmountable odds.' That's quite a challenge, but I look forward to it eagerly.

Regarding the future of our airplane, it will be around well into the next century. I foresee some missions and tactics changing to meet future threats and requirements, but the navigator will remain an integral part of the C-130. Our toughest mission is tactical aerial delivery, for which the navigator is an absolutely indispensable crew member. The C-130 nav's role may change to some degree as tactics change and new aircraft equipment is added; however, that role will not be less important and, in all likelihood, its importance may grow. Ours has always been a navigator's mission and that's not going to change."

About navigator command opportunities, Col Morey states: "I firmly believe that command of any organization will and should be bestowed upon the individual best qualified. In a flying squadron, idealistically, that person might be either a pilot or a navigator. Right now, it's going to be a pilot in most cases, simply because the pilot, by virtue of experience and grooming, will probably be the most ready for command. The inertia of our system has prevented us from really preparing very many field grade navigators for command. At the same time, too many in year groups now being tapped for commanders have fallen into the 'I'm just a nav' syndrome and haven't sought opportunities to properly prepare themselves. I encourage today's young navigators to view themselves first as officers, second as operators, and third as navigators. By 'operator,' I mean you

should learn the ropes of an organization—see how it's put together to meet its mission. Many crew members have no idea of the tremendous effort involved in operating a flying squadron, let alone a wing. The more you can learn about this, the better. Those who have prepared themselves properly will be ready for command when the opportunity arises. Rated supplement tours are valuable but not essential for career broadening since a number of very important rated staff jobs are available. These can show you the whole spectrum of operations. I now see the inertia within the system eroding fairly rapidly and I am very glad to see that many of our younger troops are avoiding the 'just a nav' syndrome and are immersing themselves totally in their units. More and more navigators will be ready when their time comes, and it will come sooner than you think."

Colonel Morey is a graduate of Squadron Officer School, Armed Forces Staff College, Air Command and Staff College, and Air War College (by seminar). He also holds a master's degree in Personnel Management from Central Michigan University. "I have found that higher education and PME can provide an entirely new outlook since you are exposed to areas outside your normal regime. I encourage all young officers to seek opportunities for education—a very important part of the preparation process for command or higher-level staff duties. As navigators prove their ability to command flying organizations, the opportunities will increase. It is up to us to prepare ourselves by being the best officers we can be, knowing and performing our mission better than anyone else, and making the most of every opportunity. If we do, our future will be bright indeed."

FROM THE EDITOR

It would be surprising if anyone is unfamiliar with Project Warrior after its tremendous exposure in Air Force media and official communications. Our office literally has been blitzed over the past six months with letters, bulletins, and news releases explaining the project's intent.

I am glad for such strong emphasis on this worthwhile program. Past war-fighting lessons teach us a great deal—knowledge that could decide the outcome of a future war or, better still, preclude one.

In outlining project objectives, Lt Gen Jerome F. O'Malley, Deputy Chief of Staff, Plans and Operations, stated that Project Warrior should strive to improve our understanding of airpower and its role in military strategy, tactics, and logistics. The General also advocated an increased appreciation of airpower's contributions to our national defense policy. THE NAVIGATOR solidly supports these goals.

Our cover painting of the magnificent B-36 sports a Project Warrior logo—just one small sign of our commitment. This issue includes three articles specifically aimed at Project Warrior's historical theme. Our story about the B-36 Peacemaker relates many interesting facts about an aircraft that won the hearts of many aviators. The short feature, "Pacific Pioneers," commemorates the 55th anniversary of the first military flight from the US mainland to Hawaii. "Navigation—A Proud Heritage" reflects upon our very roots with remembrances of our commercial, Army Air Corps, and Air Force navigation predecessors.

I hope you enjoy these recollections and I encourage you to study and share navigation history. We especially would like to include stories about navigator pioneers and heroes, like the five navigator/observer/bombardier Medal of Honor winners. If you would like to research and write their stories, now is an ideal time. Thank you for your continued interest and support.

TO THE EDITOR

Dear Editor

Just read your Summer '82 issue and, as usual, you all did a great job. However, on page 27, in Capt Meyer's article "Rescue at Sea," you showed an illustration of a KC-135 about to perform a drogue refueling. I'm sure that Captain Meyer (whom I served with in the 305 ARW) would agree that this rendition is inaccurate. All KC-135 crew members know that the "basket" must be attached to the boom prior to flight and does not come out of the right rear of the fuselage. Perhaps this was just a disguised attempt to see how closely we read your magazine. You folks put out a good product—I look forward to your next publication.

CHRISTOPHER G. KNOWLES, Capt, USAF
English Instructor, USAF Academy

Thanks for pointing out our error. In illustrating the S-3 aerial refueling for Capt Meyer's article, we researched our files for a photo depiction. As a model for the illustration, we used a photo of an S-3 refueling from a KC-10. Inadvertently, when substituting a KC-135 for the KC-10, we used the drogue system as pictured. Not being a SAC type, the graphic inaccuracy escaped my detection.

We pride ourselves on the quality and accuracy of our product. Occasionally though, errors do slip past us. We appreciate your feedback setting us straight. It's one more way we know we're read.
THE EDITOR

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Affectionately known to those who built and flew it as the Aluminum Overcast, the Flying Cigar Humidor, the Magnesium Monster, the Billion Dollar Blunder, and the Mailing Tube with Wings, our cover displays an RB-36F, the reconnaissance version of Convair's awe-inspiring bomber. Read more about the Peacemaker on pg 9.

If you've ever thought that ASTRA might be for you, share an insider's account on pg 5.

Distribution: One copy per two navigators.

NAVIGATING AROUND THE AIR STAFF

an Inside Look at the ASTRA *program*

Captain Thomas P. WADDELL
38 SRS
Offutt AFB, NE

"Congratulations, Tom! You've been selected for the ASTRA program," my squadron commander announced one spring morning.
"Great! Where will I be working, sir?"
"This message says you'll be going to the Pentagon—an office called AF/RE," replied Lt Col Scott.
"That's fantastic! What the heck is AF/RE?"
Now, at the end of my ASTRA tour, I know AF/RE is the Office of the Chief, Air Force Reserve, and I know how the air staff functions. My view of the big picture has been expanded through my assignment to the Air Staff Training Program (ASTRA). In this article, I hope to give you a clear picture of ASTRA, too. First, I'll explain the program and then describe its function and benefits.

An ASTRA assignment begins with AFR 36-20, chap 8, Special Duty Assignments (SDA). A 12-month special duty assignment, ASTRA is designed to expose young officers to air staff operations as management interns. To qualify, an officer needs not more than six or less than four years of commissioned service. He/she must have completed SOS, have an outstanding performance record, and meet other AFR 36-20 requirements.

That sounds easy, but what does it really take to get into the program? You merely complete a Form 90 with the SDA block coded for ASTRA. The CBPO then updates its records to tell MPC of your application. Qualified officers' applications are reviewed regularly by the ASTRA selection board. For details about the selection process, I talked with the ASTRA program manager at MPC (AV 487-4053). The board consists of senior Air Force officers from MPC. They review an average of over 400 records, selecting about 18 percent. Each record is reviewed for job performance, PME, academic background and job progression—a whole-person philosophy. After

the records are scored and ranked, the top individuals are the ASTRA selectees.

The board reviews only the officer's OERs, awards and decorations, official photo, and career brief (summary of personal data). Letters of recommendation and other material that may influence selection are not permitted. The selection process resembles that of a promotion board. To give you an idea of the qualifications of officers serving ASTRA tours with me, 30 individuals were surveyed. Following are the results of the informal, unofficial survey conducted by Capt Chip Diehl, Air Staff Cost and Management Analysis Branch.

SOURCE OF COMMISSION:

15 AFA

8 ROTC

7 OTS

SPECIALTY RATING:

14 pilots

7 navigators

9 non-rated

10 flight examiners, 8 flight instructors

PME:

SOS-

5 by correspondence

11 in residence

14 both methods

INTERMEDIATE/OTHER SERVICE

5 other programs

11 distinguished graduates, 7 top one-third

EDUCATIONAL LEVEL:

14 graduate degrees

OERs:

23 general officer indorsement

21 numbered AF or higher

PERSONAL INFO:

29 male

1 female

Secretary of the Air Force George V. Orr, Jr., addresses ASTRA officers.

ASTRAs are assigned to Pentagon directorates for training at the highest staff level. Each directorate advises MPC on required officer qualifications. Those desires are matched with the talents and skills of the selectees. The list is then given to the MPC career managers for specific assignment dates. Each directorate manages its ASTRAs differently, following basic guidelines from MPC. I was assigned to the Office of Air Force Reserve Operations and Plans Division, Plans Branch. Other selectees went to various levels, from the Office of the Secretary of Defense on down. These included personnel, public affairs, plans, programs, engineering, R&D analysis, and administration. Detailing each assignment would take a volume of text, so I'll concentrate on the tours of some navigators who served coincidental tours with me.

The ASTRA charter states that officers will be assigned as management interns. This may be misleading. Most ASTRAs work as action officers preparing and coordinating staff actions throughout the Pentagon. These include anything from program initiative packages to letters of appreciation. In many divisions, ASTRA duties depend upon the officer's experience, knowledge, and initiative.

Capt Kirk Brown, a C-141 navigator, developed detailed guidance on force and equipage programs, basing/bed-down of MAC aircraft, and associated reserve force matters for Operations Support Airlift. Capt Tony Sharon, a KC-135 navigator, now with the 1st Combat Evaluation Group, Barksdale AFB, worked as a congressional activities specialist with the Directorate of Research, Development and Acquisition. He prepared briefings to answer congressional inquiries about Air Force weapon systems development and acquisition. My job, with the Air Force Reserve Plans Branch,

involved preparing and reviewing operations plans. Also, I helped write the USAF Reserve Objective and Capability Plan, a 15-year projection of mission capability. Since the Air Force Reserve has a broad mission, I was able to study the roles of airlift, air refueling, air combat and rescue, as well as the associated missions of many non-flying units.

Although jobs vary, from that of Capt Terry Mayer, a HC-130 navigator working in Middle East and Africa plans, to Capt Joe Stein, a B-52 radar navigator working in transportation management, the common thread is the air staff structure. Upon concluding his tour, Capt Gary Shugart, a B-52 radar navigator, said, "As a junior officer, ASTRA gave me the opportunity to witness the many air staff roles and functions. This experience cannot be obtained by any other means. I developed a deep appreciation for the various programs managed and integrated at the air staff level." This opportunity to see the big picture is probably the biggest motivator among the ASTRAs.

What benefits does ASTRA offer? Probably the greatest advantage is working at the air staff level as a junior captain. This experience prepares each ASTRA for similar work at any command level, from squadron through MAJCOM. Other associated benefits are also worthy of mention.

Currently, we manage social activities through a centralized coordinator. One such activity is an excellent speakers program. Two or three times a month, speakers from the local civilian and military communities are invited to address the ASTRAs on a variety of subjects. During my tour, the speakers included the Honorable Verne Orr, Secretary of the Air Force; General Lew Allen, Chief of Staff, USAF; General Robert Mathis, Vice Chief; and Lieutenant General Hans Driessnack, Assistant Vice Chief. From the civilian community came Senator Barry Goldwater, columnist Jack Anderson and former presidential press secretary Jody Powell. Also, we heard from air staff general officers and we toured the State Department, CIA, and FBI. All in all, the speakers program, which continues to expand, provides a unique opportunity to meet the nation's influential leaders.

Maj Gen Guy L. Hecker, Jr., Chief of the Air Force Issues Team, speaks to an ASTRA group.

Another benefit is the opportunity to attend many of the military-related events held in the Washington, DC area. The annual Air Force Association (AFA) national convention and associated industry displays are examples. Many of us attended the AFA tribute to the Crusaders of Airpower. The guest list for that event read like a history of aviation. Several senior Air Force leaders attended, as well as aviation pioneers General Jimmy Doolittle and General Curtis LeMay.

As the hub of national government, the Washington area provides countless opportunities to enjoy museums, cultural events, and other attractions at little or no cost. The area affords activities not found in many other large metropolitan environments.

Professional development cannot be overlooked when weighing the plusses of ASTRA. An officer builds professional knowledge that can lead to opportunities unavailable to personnel at unit level. Enhanced professional development and good follow-on assignments improve promotion potential. Although ASTRAs are not directly favored in the reassignment process, their "roll out" assignments are coordinated between the ASTRA program manager and career resource managers at AFMPC.

Some drawbacks exist with the benefits. One is the very high cost of living in Washington and its surrounding area. Another is the fact that ASTRAs lose a year of flying gate credit. Classified under student status for flight pay, ASTRAs receive no flying time or gate credit during the program. In spite of these drawbacks, the consensus among the ASTRAs is that the benefits far outweigh the disadvantages.

Now that you understand the selection process, the assignments, and the benefits and drawbacks of the program, what is left? I think it is important to pass on some comments I have heard in the past year.

In March, I visited with Lt Gen Hans Driessnack, Assistant Vice Chief of Staff. I asked for his views on the program and his advice for

young officers interested in ASTRA. Gen Driessnack stated, "The ASTRA program benefits both the Air Force and the officer. ASTRA officers bring a fresh perspective to the air staff that is unencumbered by the bureaucratic process. They bring a broad spectrum of experience direct from the field, from all specialties and all commands. The program allows them to present their views directly to the senior staff, based on early impressions of current programs."

1982 ASTRA navigators, from left: Captains Bill Osterweld, Rick Taylor, Terry Mayer, Joe Stein, Dave Bean, and Tom Waddell.

Pictured from the left: Captains Don Pettit, Chip Diehl, and Dave Bean share views on a guest speaker's address.

Gen Driessnack went on to say, "The ASTRA program allows officers to see how the senior staff, the leadership, is involved in all aspects of readiness and quality of life issues. They see that the air staff is a 24 hour-a-day, 7 day-a-week operation. In addition, ASTRA allows unequalled exposure to a broad view of national policy, both within the air staff and on the Hill. The senior staff will continue to support the program as a valuable training base for future air staff assignments." Gen Driessnack gave the following advice to young officers looking toward an ASTRA assignment, "Show an interest beyond your normal duties, a willingness to expand your responsibilities and enhance your contributions to the overall mission."

Many of us echo the General's advice. Capt Dave Bean, a KC-135 navigator, stated, "I see many 0-6 navigators and even 0-7 and 0-8 navigators here on the air staff. Each of them worked to his utmost potential and didn't allow his wings to limit his career. Try for this or any other program you're interested in and eventually your hard work will pay off." Capt Tom Konecny, another KC-135 nav, added, "As you've heard before, do your best as an officer as well as with flying and additional duties."

Well, that's the Air Staff Training Program in a nutshell. Opportunities to work on the air staff as a company grade officer are limited, but the program is here. Personnel in the AFMPC ASTRA office say that applicant qualifications get better with every board. The problem is that many qualified people don't apply. There is no penalty for applying. The more who apply, the better the program will be.

I can only add that after 4½ years as a flier, the ASTRA program allowed me to expand my knowledge of the Air Force mission well beyond the confines of the KC-135 nav seat. If I could recommend any program to young officers just coming on board, it would be this one. ASTRA challenged my talents, developed my skills, and provided educational experience unequalled thus far in my career.

So, if you are interested, go to the CBPO, review AFR 36-20, chap 8, and take a few minutes to fill out a new Form 90. It's as easy as that! If you need more information, contact Capt LaMarr Anderson, MPC/RPC2, Randolph AFB, Texas (AV 487-4053). You never know—maybe one morning your squadron commander will call you into his office and say, "Congratulations..."

Capt Waddell graduated from Montana State University in 1974, and completed UNT in 1976. After CCTS, he was assigned to the KC-135 at Fairchild AFB, before obtaining a master's degree from Gonzaga University in Washington. He next served as an ASTRA officer at the Pentagon. Capt Waddell is a navigator with the 38 SRS.

THE B-36 PEACEMAKER

Lieutenant Colonel William W. MILLER
Air War College
Maxwell AFB, AL

The Convair B-36, the world's largest bomber in length and wingspan, was conceived in 1941. Although not yet officially involved in World War II, the United States was concerned that Nazi Germany would conquer all of Europe. If that happened, America would need a bomber with intercontinental range to strike enemy targets. On 11 April 1941, the Army Air Corps requested bids on a bomber which could deliver a 10,000 lb bomb load to targets 5,000 miles away at speeds between 300 and 400 kts.

In 1941, the largest Air Corps bomber in service was the B-17C with a 2,000 mile range. A new bomber, the B-24A, with a 2,200 mile range, was tested, certified, and awaiting delivery to flying units. Boeing (XB-29), Douglas (XB-19), and Consolidated Aircraft (XB-32) were all working on longer range aircraft. Consolidated enlarged its proposed XB-32 and sent the design, renamed the XB-36, to the Air Corps. The initial contract, approved 15 November 1941, was for two XB-36 airplanes, with the first to be delivered in the spring of 1944.

The Japanese attack on Pearl Harbor, plus the Royal Air Force's victory over the German Luftwaffe during the Battle of Britain, shifted Consolidated's priority from B-36 development back to B-24 production. Still, work on the XB-36 continued. The early conception model was a basic design with slender fuselage, twin tail and six-pusher engines. A 1/26 scale wind tunnel model was tested and, by August 1942, a full scale mockup was built and moved to the new government plant in Fort Worth, Texas. Some of the original features, including the B-24-style twin rudder, were changed to strengthen the design before the first prototype.

During the initial design phase, B-24 production drained experienced personnel as Consolidated supported the war effort. However, the XB-36 program was accelerated when Gen Hap Arnold ordered the highest priority for use of the B-36 in Pacific operations. A letter of intent for 100 B-36s was issued in July 1943, but the B-29's success and the climactic use of atomic bombs hastened the end of WWII. Recognizing the primary role played by the strategic bomber in the defeat of Germany and Japan and realizing the need for an improved intercontinental bomber, the Air Corps continued B-36 development. The first prototype flew on 8 August 1946, nearly five years after ordered.

As with many new aircraft, problems developed causing redesign of the landing gear, engine cooling system, wings, and engine structure. During production, considerable controversy brewed between the Navy and Air Force over the

XB-36

B-36Ds undergo final assembly.

B-36J—the last production version.

Photos courtesy of General Dynamics.

YB-60

B-36 carrying a B-58.

NB-36H sporting the Convair logo.

worth of a strategic nuclear bomber. Gen Curtis LeMay, the then-new Commander of the Strategic Air Command, supported the B-36 claiming, "We can get a B-36 over a target and not have the enemy know it is there until the bombs hit." The Navy, smarting from a budget reduction and cancellation of a large carrier, strongly opposed a defense strategy based only on aerial atom bomb delivery. Russian technology, however, continued to advance and, by the end of 1949, Russia had atomic weapons and a long range bomber aircraft to deliver them.

The B-36 was an expensive aircraft for its time, with early models costing over six million dollars. However, with the advent of the Korean War, ample funds were budgeted for both strategic bombers and Navy carriers. The issue of B-36 funding waned.

Besides being expensive, early B-36 production aircraft were criticized for being too big and too slow. Their top speed was only 381 mph at 42,000 feet. Still, the aircraft was impressive. On 7 December 1948, a B model flew from Carswell AFB, Texas, to Hawaii and made a successful bomb run without detection. It then returned to Carswell, completing an 8,100 mile non-refueled mission. In March 1949, another crew set a new non-stop long distance record of 9,600 miles.

Also, in 1949, the Russians introduced a new jet fighter, the MIG-15, with a service ceiling of 51,000 feet. To increase the B-36's penetration speed and survivability against that new threat, a pair of turbojet engines were added under each wing—the same engines designed for the B-47. The jet-powered model was designated as the B-36D. Also developed was a reconnaissance version of the B-36 which carried 14 cameras in its bomb bay.

The B-36D carried a crew of 15, including a navigator, bombardier, forward observer, and a radioman who operated the electronic countermeasures. For bombing accuracy, the K-1 bombing and navigation system was employed. It consisted of radar and optical equipment for blind and visual bombing capability. Later aircraft modifications replaced the K-1 with the K-3A system.

To improve bombing accuracy, the Strategic Air Command initiated a command-wide bombing competition in June 1948. Convinced that this first "Bomb Comp" sharpened aircrew skills, Gen LeMay made it an annual affair. The B-36 first entered competition in October 1949 with a B-36 aircrew winning the individual crew trophy. Photo reconnaissance and navigation contests were added to the competition in 1952 with an RB-36D winning each of those categories that year. B-36 crews went on to win bombing competitions in 1953, 1954, and 1956. They also won the Reconnaissance Competition in 1953 and 1954.

During its operational life span, the B-36 underwent many modifications, both as a bomber and a reconnaissance aircraft. Production concluded with the B-36J, of which 33 were built. Several other unusual versions were tried, one designed to carry a fighter aircraft in the bomb bay or two fighters attached to the wing tips. Also, three B-36H models were modified to carry the Bell GAM-63 "Rascal" air-to-ground missile. All three of these experiments were cancelled before becoming operational.

Although the B-36 only flew operationally for ten years, during the late 1940s and 1950s it reigned as a proud symbol of America's ability to deliver weapons anywhere in the world. Paradoxically though, the aircraft never dropped a bomb nor fired a shot in anger, but it fulfilled the role of strategic deterrence until replaced by the B-47 and B-52. The last B-36, a J model assigned to the 95th Bomb Wing, Biggs AFB, Texas, was retired in February 1959 ending the era of propeller-driven bombers.

As with all heavy bomber aircraft, the primary mission of the B-36 was controlled by navigators and bombardiers, upon whose shoulders rested responsibility for target location, penetration, and bombing accuracy. The navigator was vital to the B-36 and its role in national defense.

Lt Col Miller graduated from Grove City College in 1964 with an ROTC commission. After UNT in 1968, he served as a B-52 instructor navigator and instructor radar navigator, followed by 140 B-52 missions in Vietnam. In 1975, he obtained a master's degree from Northern Michigan University. Assigned to Mather AFB in 1977, he served in various positions before assuming command of the 449 FTS. Lt Col Miller is now attending the Air War College, Maxwell AFB.

PHANTOMS *and* FEATHERS

Editor's Note: The following story dramatically illustrates the fact that navigators are not just passengers. Capt (then 1st Lt) Fred Wilson truly proved himself a professional aviator. We are pleased to recognize Capt Wilson's receipt of two special awards. He earned TAC's "Aircrew of Distinction Award" for September 1982. Also, Capt Wilson and his pilot, Capt Greg Engelbreit, received the Air Force Association's "Earl T. Ricks Memorial Trophy" in September. Congratulations from THE NAVIGATOR.

Captain Fred WILSON
Idaho ANG/190 TRS
Boise ID

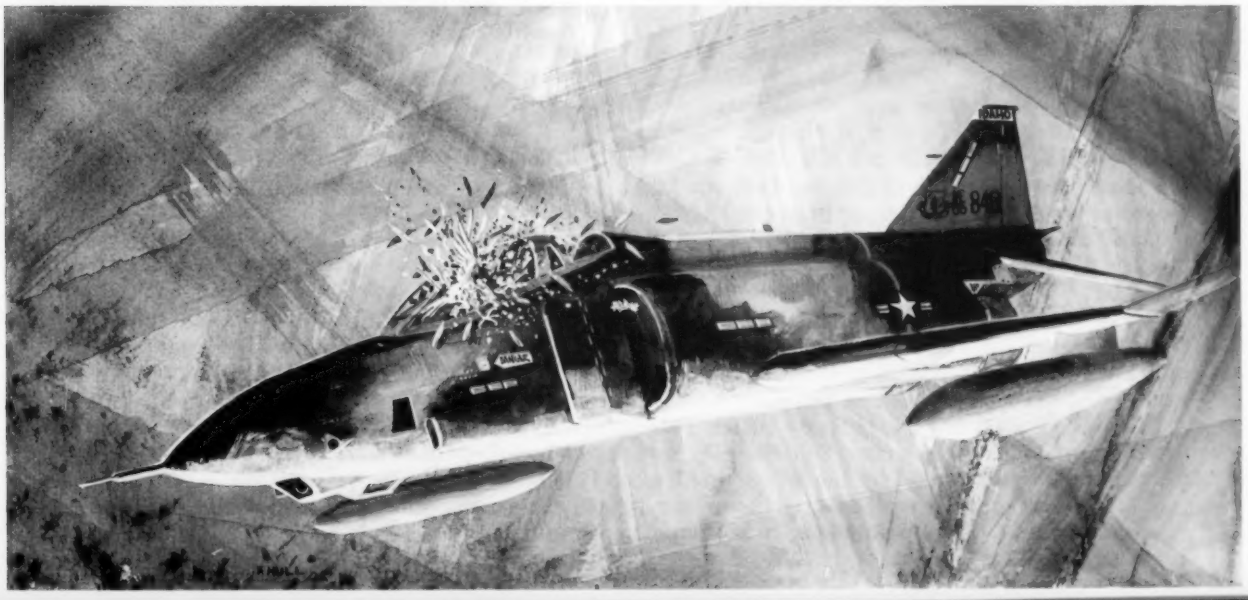
It started as a typical night radar low-level ride in an RF-4C on April 8, 1982. I arrived at the squadron about 1730 to start planning the low-level route. I had intended to fly IR 303, but it was reserved by crews from Mountain Home AFB, so we planned VR 1303 instead. I already had a map drawn with targets and radar shading for night flying. After reviewing the map to be quite familiar with the route, I briefed the pilot on what I wanted him to do during the radar low-level portion of the mission.

Predeparture, takeoff, and descent to low level were routine. At 1915 local time we entered the low-level corridor heading west. We were operating as if it were dark because the pilot, Capt Greg Englebreit, had difficulty in maintaining visual ground clearance while looking into the setting sun.

We passed the first target and made a slight right turn to a heading of 283° at approximately 1,000 ft AGL and 480 kts. Bang! The cockpit was full of feathers! Without warning, a whistling swan had exploded through the left quarter panel of the windshield damaging the front cockpit radar scope. Also, the impact and shattered glass injured the pilot's left shoulder and damaged his parachute hard shell and ejection seat. Bird remains spattered into the rear cockpit and across my visors and helmet. The impact force of the debris in the rear was sufficient to knock the adjustment knob off my helmet visor.

With the initial impact, Greg reacted by pulling up. I instinctively took the stick and continued the climb. Several seconds elapsed before I fully realized what had happened. Our RF-4C had struck a bird. My pilot was injured and disabled. I now had control of the airplane—every backseater's nightmare. I turned toward Boise while trying to reach Greg on interphone. Later, I would learn that debris from the bird's impact had unplugged Greg's headphones. He was with me, but unable to communicate. He could not help talk me down.

By the time I completed the 180° turn toward Boise (about 100 miles away) and initiated my mayday calls, Greg had managed to lower the landing gear, much to my relief. A few minutes later he was able to lower the flaps with his injured left arm.



After what seemed several eternities, I raised Boise Approach Control. They told me that another RF-4 was being vectored to us by Salt Lake Center. Shortly after, I looked out and saw an airplane off my left wing. Maj Bill Miller was piloting FANGO 45 with Capt Mike McGrath in the back seat. I called them on UHF and directed them to cross over to the right wing, since vision to my left was almost completely obliterated by dried blood and bird remains. Maj Miller carefully examined our Phantom and reported no visible damage other than the shattered canopy. He said he could see Greg moving about in the front seat. At least I knew my pilot was still conscious. With Maj Miller's ship now in formation, we began preparing for the emergency landing.

We decided that the best emergency field would be Mountain Home AFB, some 40 miles east of Boise. It was now growing very dark. At 170 kts, I thought we would never see Mountain Home's runway. I began reviewing landing procedures and rehearsing the formation approach in my mind—it would be my first.

Suddenly the master caution light illuminated. The tiny light is designed to get attention but, under my circumstances, it looked four feet square! After expressing my concern about the light to Maj Miller, he answered that my arresting hook had been lowered, thus illuminating the light. Greg must have noticed it too, because in a moment I saw it go out. He had reset it.

When we arrived at Mountain Home, we were south of the field. We made a 180 degree turn to the left to line up on a 15 mile final to runway 30. During the turn, as well as down final approach to the runway, I flew close formation, keeping our wing tips about 10 feet apart. With reference only to FANGO 45, I flew my airplane to match that of my leader. Everything he did, I duplicated. I was so engrossed in the formation approach (as I should have been) that I was unaware of my altitude until the approach lights passed by on the other side of lead. As we touched down, still in formation, Maj Miller executed a touch and go while I lowered the nose and engaged the approach-end arresting cable.

After stopping, we sat on the runway with no way to shut down the engines from the back seat. Ground crew personnel climbed aboard the airplane and checked my ejection seat before giving a thumbs up. They next leaned over the engine intake, opened the front canopy, and pulled the throttles to OFF, shutting down both engines. Crash and rescue specialists then took over, removing Capt Engelbreit from the plane and rushing him to the hospital. My ground egress was uneventful.

Luckily, Capt Engelbreit's injuries were not severe and he will return to flying status. After being seriously injured, he still completed many tasks through training and instinct. These included lowering the landing gear, flaps, and tail hook, squawking emergency, activating the landing lights, and locking his shoulder harness—all while in intense pain and only semiconscious.

From this experience, I have a much greater appreciation for why we constantly practice emergency procedures until we can recite them in our sleep. I will also show an extra glint of pride in my eyes the next time I'm asked to explain the duties of a "backseater."

Capt Wilson attended Ricks College and Idaho State University before enlisting in the Air Force for 2½ years. After receiving his commission in the Idaho ANG, he completed UNT in 1977. In addition to his WSO duties, Capt Wilson is Life Support Officer for the 190 TRS.

About the Idaho Air National Guard

Federally recognized on 13 October 1946, the Idaho Air National Guard has a proud and distinguished record of service to the state and the U.S. Air Force.

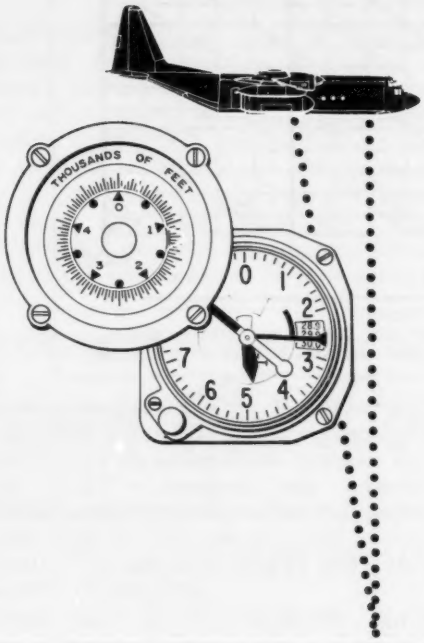
Eight separate units comprise the 124th Tactical Reconnaissance Group, part of the Air Force's Tactical Air Command. Nearly 900 officers and airmen perform and support the photo reconnaissance mission.

The 124th's RF-4C Phantoms train for their combat photo intelligence role in time of war but they also serve their state and nation in peacetime efforts. After the 1976 Teton Dam failure in eastern Idaho, 124th aircraft and personnel provided immediate reconnaissance of the dam and flooded areas—just one example of the Idaho ANG's humanitarian mission.

The Idaho Guard has flown many different aircraft in a variety of missions. P-51 "Mustangs" were first to sport Idaho ANG colors. Other airplanes to follow included the T-33, F-86, F-94, F-89, and the F-102, which was replaced by the RF-4C in October 1975.

Many honors have been bestowed upon the 124th during its colorful history. The Idaho Air National Guard's future promises to uphold that fine tradition.

The PASTAGRAM -revised and explained



Major Michael J. SIEVERDING
34 TATG/TTX
Little Rock AFB, AR

Many of you have been practitioners of pressure pattern navigation for several years and are at least somewhat familiar with the PASTAGRAM. Others of you, who have come to the long-range navigation trade since the proliferation of inertial systems, probably know little about what a PASTAGRAM is or what it can do for you.

The PASTAGRAM is a graphic form used to improve the accuracy of pressure lines of position (PLOPs) when aircraft pressure altitude (PA) changes between "D" readings. It yields an "S" factor that ultimately corrects your PLOP for the change in PA. Many of today's navigators consider the PASTAGRAM complicated, burdensome, and not worth the effort, even though its use can improve PLOP accuracy by 20 nautical miles or more.

Originators of the PASTAGRAM fully understood why the procedure works and developed methods to use the form to meet their needs. As procedures were handed down through generations of navigators, the reasons they work have been deemphasized to the point where many have been lost, misplaced, or distorted. Modern instruction emphasizes how to do the task, not why it works. With today's aircraft and missions, yesterday's procedures may no longer be suitable. Technical introspection keeps the art of navigation dynamic and efficient. This article will not only explore the whys of the PASTAGRAM, but also introduce a PASTAGRAM better suited to today's requirements, and even relate a technique to replace the form.

WHY DOES IT WORK?

The source equation for both the PASTAGRAM and PLOP by temperature (see 1981 Winter edition of THE NAVIGATOR) is the geopotential airmass equation:

$\frac{TA}{PA} = \frac{AK}{SK}$ WHERE TA = TRUE ALTITUDE
PA = PRESSURE ALTITUDE
AK = ACTUAL TEMPERATURE DEGREES KELVIN
SK = STANDARD DAY TEMP DEGREES KELVIN FOR PA
SK = 288.16 (1.9812 x PA)

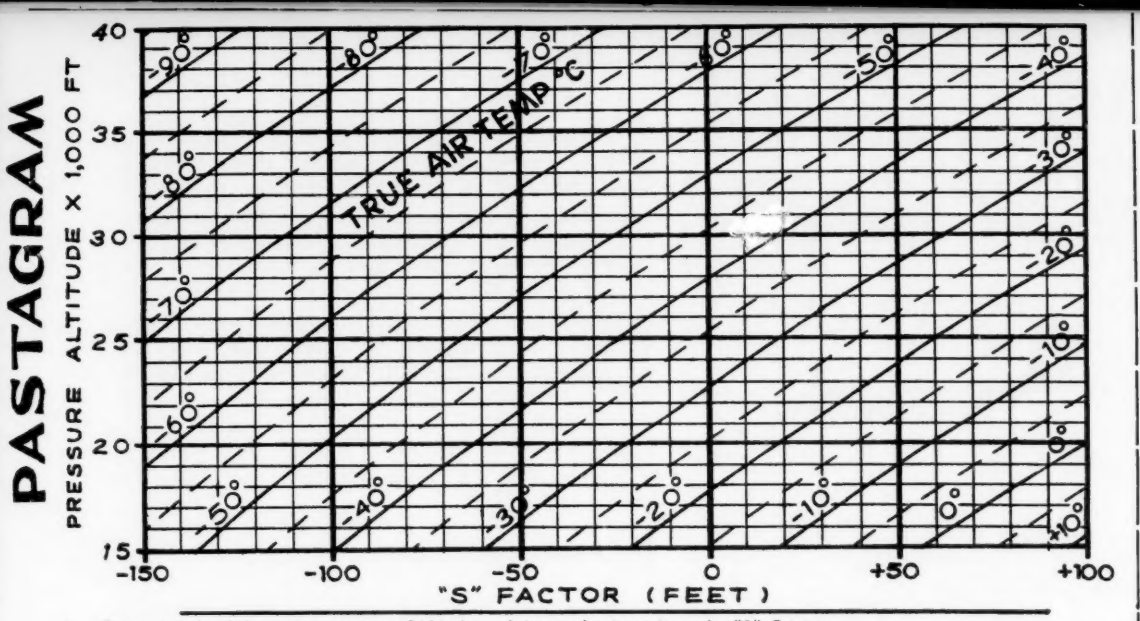
This equation determines how far an air mass with a non-standard temperature will rise or descend. The equation is dependent upon an air mass with a standard amount of moisture following a standard temperature lapse rate, and is a functional approximation of real world conditions. Through algebraic gyrations and substitution, the geopotential air mass equation can be altered to express "S" factors:

$S = \frac{TD}{SK} \times 1000$

WHERE TD = TEMPERATURE DEVIATION FROM STANDARD DAY

The ratio of in-flight temperature deviation (TD) to what the temperature should be on a standard day (SD) determines the "S" factor for each foot of PA change. This "S" factor is merely an adjustment for temperature deviation. The temperature ratio is multiplied by 1,000 because current convention applies the "S" factor to 1,000 foot increments of PA change.

The Troposphere extends from the earth's surface to the Tropopause. PASTAGRAM theory applies only when the aircraft is flying within the Troposphere. The Tropopause altitude varies, with its altitude more properly defined by an air temperature of -56.5°C than by the Standard Day height of 36,089 feet. For this reason, when true air temperature (TAT) is less than -56.5°C, "S" factors could be very unrealistic and should be used with caution.



1. Enter graph with spot pressure altitude and true air temp to gain "S" Factor.
2. Change sign of "S" if descending. Apply "S" to initial "D" reading for each 1000 ft of altitude change.

NOTE: When true air temp is less than -56.5° "S" Factors are representational and must be used with caution.

THE UPDATED PASTAGRAM

A computer program using the "S" factor equation was run on a MAC celestial training minicomputer device. The minicomputer generated 162 data points which were hand plotted to produce the above PASTAGRAM.

PASTAGRAMS currently in use were traced from the bottom half of the original PASTAGRAM, a form designed for more than just "S" factor extraction. This form included a range of TD not found in nature, pressure altitudes useful only to non-pressurized aircraft, but it excluded useful data for PA above the Standard Day Tropopause (36,089 feet). These PASTAGRAMs included all the faults of the original, plus the tracing was often poorly done. The updated PASTAGRAM is more accurate and much easier to use because of its expanded scales.

UPDATED PROCEDURE

The long-practiced procedure of entering an average PA and true air temp on the PASTAGRAM is unnecessary. Spot PA and TAT values, taken before, during, or after an altitude change, produce nearly the same "S" factor. Any temperature inversion great enough to cause a significant "S" factor error would cause an enormous error in "D" readings that no "S" factor could correct, average or spot. Noting several PA and TAT values, averaging them, and entering the averages on the PASTAGRAM may comply with current procedure, but this process contributes little, if any, accuracy and consumes valuable time. Using spot PA and TAT for the "S" factor is easier to do, requires no PASTAGRAM interpolation, and produces a PLOP closely resembling that achieved using averaged values.

"S" FACTOR TECHNIQUE

During development of the updated PASTAGRAM, it was noted that the "S" factor almost always equaled four times the temp dev. This nearly linear relationship of "S" factor to TD is caused by SK values that are close to 250° Kelvin at today's flight altitudes. SK is equal to 250° Kelvin at 19,261 feet. By substituting 250 for SK in the "S" factor equation:

$$S = \frac{TD}{250} \times 1000$$

IT IS FOUND THAT:

$$S = 4 \times TD$$

The navigator need only determine a spot TD before, during, or after an altitude change and multiply it by four to compute an "S" factor. The PASTAGRAM is needed only if the temp dev is extreme and the PA exceeds 30,000 feet. If the aircraft altitude change is 2,000 feet or less at reasonable range of temp dev, the navigator could confidently use this technique and never have to employ the PASTAGRAM at all. The technique does produce some error in the "S" factor as flight conditions vary from zero TD or 19,261 feet PA. SACM 105-7 and AFGWC weather histories indicate that the probable range of TD decreases

as altitude increases. Therefore, assuming that eight feet of "S" equals one mile of PLOP displacement, the error equals less than one mile for each 1,000 feet of PA change during an annual range of temp dev anywhere in the world.

CONCLUSION

PASTAGRAM theory must be more widely understood and procedures simplified, when practical. Not using the PASTAGRAM or "S" factor technique during an altitude change can jeopardize a potentially useful PLOP and detract from position accuracy—still the name of the game for aircraft navigators. Fuel costs in today's Air Force are ever escalating. Frequent PASTAGRAM use becomes necessary when step climb profiles are conducted for fuel conservation.

The author welcomes any comments regarding this subject and will furnish more detailed PASTAGRAM data on request. Please direct correspondence to THE NAVIGATOR.

A 1974 graduate of the University of Minnesota, St Cloud, Maj Sieverding was commissioned through OTS. After UNT, he was assigned to Clark AB. Next came assignments to RC-130A photo mapping, the WC-130 at Keesler AFB, and instructor duty at Mather AFB. Maj Sieverding presently is a C-130E Simulator Certification Team Member.

from the Log

DATE TYPE NUMBER PILOT DEP DEST ARR TIME

A FREAK OF NAVIGATION

As reported by Charles McCabe aboard the SS Santa Maria enroute to Cartagena.

It is a tale that most men who sail know about, but it was new to me and perhaps it is to you. I learned about it on the bridge the other night reading the account by John Euller in "Ships and the Sea."

The date was Dec 30, 1899. Captain John D.S. Phillips had just got the news. The navigator had just finished working out a star fix and brought Captain Phillips the results. His ship the Warrimoo's position was spotted at about latitude 0 degrees 30 minutes north and longitude 179 degrees 30 minutes west. The ship was halfway through the waters of the mid-Pacific on her way from Vancouver to Australia.

First Mate Dayldon broke in, "Captain, do you know what this means? We're only a few miles from the intersection of the Equator and the International Date Line."

Captain Phillips knew exactly what it meant, and he was prankish enough to take full advantage of the opportunity for achieving the navigation freak of a lifetime. In an ordinary crossing of the date line it is confusing enough for passengers because they lose a day, but the possibilities he had before him were sure to confound them for the rest of their lives.

The captain immediately called four more navigators to the bridge to check and double check the ship's position every few minutes. He changed course slightly so as to bear directly on his mark. Then he carefully adjusted engine speed so he would strike it at just the right moment.

The calm weather, the clear night and eager cooperation of his entire crew worked successfully in his favor. At precisely midnight, local time, the Warrimoo lay exactly on the Equator at exactly the point where it crosses the International Date Line. The consequences of this bizarre position were many.

- The forward part of the ship was in the southern hemisphere and in the middle of summer.
- The stern was in the northern hemisphere and in the middle of winter.
- The date in the aft part of the ship was Dec. 30, 1899.
- Forward, it was Jan. 1, 1900.

The ship was therefore not only in two different days, two different months, two different seasons and two different years, but in two different centuries—all at the same time. Moreover, the passengers were cheated out of a New Year's Eve celebration and one entire day. December 31, 1899 disappeared from their lives for all time.

There were compensations, however, for the people aboard the Warrimoo were undoubtedly the first to greet the new century. And Captain Phillips, speaking of the event many years later, said, "I never heard of it happening before, and I guess it won't happen again until the year 2000!"

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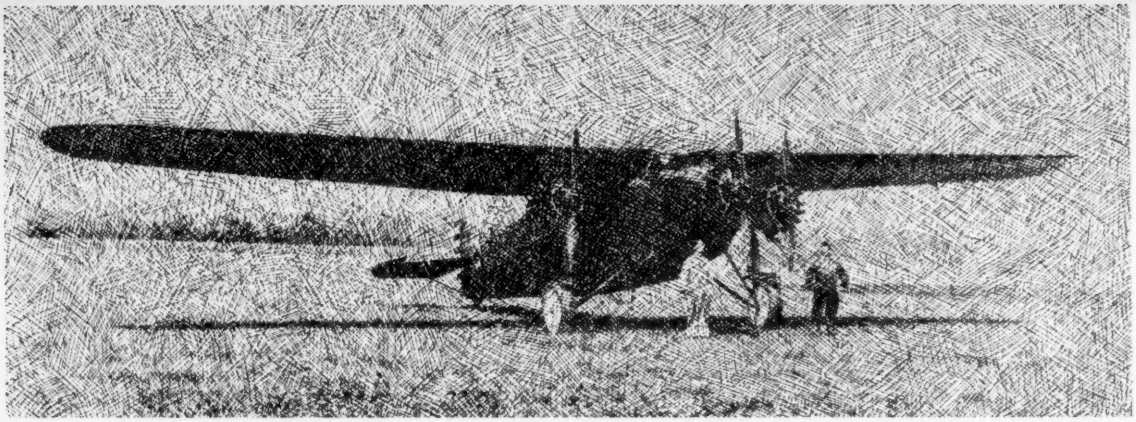
Editor's Footnote: And you thought Grid entry and exit were confusing!



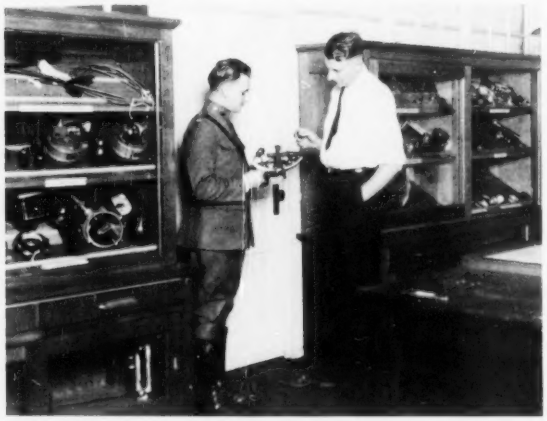
Captain Richard L. PLASKETT
452 FTS
Mather AFB, CA

These days, a flight from the west coast to Hawaii is about as routine as driving from Fresno to Los Angeles on I-5, and considerably safer. But what if there were no roads, no signs, your vehicle was extremely slow, and the driver was blind? To attempt such an unsure trip is folly, of course—or is it? Actually, the conditions for the maiden non-stop flight from the U.S. mainland to Hawaii were even more sporting. The two men who flew it were truer pioneers than those who crossed the continent in covered wagons.

Lts Hegenberger (left) and Maitland display the confidence that carried them across the Pacific.

On June 28, 1927, Lt Lester Maitland and his navigator, Lt Albert Hegenberger, lifted off from a specially-lengthened 7,000 foot strip at Oakland Municipal Airport in a modified, Whirlwind-powered Fokker Trimotor to fulfill a long-held mutual dream. Besides the standard navigation instruments (marks painted on the tail and wings to determine drift and groundspeed, smoke bombs to check winds, and an aperiodic compass for better heading reference), the Bird of Paradise also carried an earth-inductor compass, two different types of radio compasses, and a special homing device to follow a signal beamed towards Hawaii from Oakland. Although all except the magnetic compass proved useless for one reason or another, the two fliers continued on undaunted. Hegenberger still had his German bubble quadrant with direct-sighting telescope and a pile of celestial precomputations. Better yet, he had an excellent plan. By heading toward the north end of the island chain, unaccounted for increases in wind would actually blow the plane toward the islands. Maitland considered Hegenberger a "navigator without peer" but still did not realize how his faith in his partner's skills would be so gravely tested.

Flying without any form of autopilot, it was Maitland's job to keep the Trimotor at the max-range speed, above the clouds, and on the precise heading Hegenberger requested, using just a magnetic compass with no gyro—no mean task in itself. When, after only a couple of hours, the nav



Lt Hegenberger (in uniform) explains the sextant to a contemporary.

ACIFIC PIONEERS

passed a note to the pilot (interphone was as yet unheard of) asking for a 17° course correction, Maitland altered without question. Several hours passed without sighting any of the ocean-going ships supposed to pass along the sea-lane which also was their route. Hegenberger, after receiving the query from his pilot, predicted sighting the SS Sonoma in about ten minutes. Maitland's faith in his navigator and in his creator were firmly and forever cemented when, nine minutes later, the Sonoma came into view.

Celestial navigation being his primary aid, Lt Hegenberger checks his sextant.

The Fokker Trimotor, foreground, leaves San Francisco for Oahu.

Except for a temporary cessation of the number two engine as they climbed to get above the clouds for a celestial observation, Maitland stated in an interview that his only other worry was his inability to locate his sandwiches and soup which Hegenberger had brought on board with the navigation gear. Several notes were exchanged on this subject. After flying anywhere from 300 to 11,000 feet over water and through the night, Hegenberger's final fix, near the time of his ETA to landfall, placed them 35 miles north of course. He directed a 90° turn to the left. After 22 hours and 50 minutes of flying time, they sighted the Kilauea lighthouse on Kauai, and circled it until dawn when they could visually find their way to Wheeler Field on Oahu.

Finally, after 25 hours and 49 minutes, with crowds of soldiers cheering against the morning rainstorm, the two men, who never doubted themselves, their aircraft, or each other, again touched earth.

The Bird of Paradise circles for landing as Wheeler Field Army troops wave welcome.

After receiving many laudatory words and handshakes, Maitland was handed a sack by a crew chief. It contained sandwiches and soup. "Found it under your seat, sir," was the accompanying statement.

After graduation from Bowling Green State University in 1972, Capt Plaskett was commissioned through OTS and completed UNT in 1973. He then served in the B-52 at Robins AFB followed by duty at Andersen AFB. Assigned to Mather AFB in 1978, Capt Plaskett instructed with the 452 FTS before his present duty as Chief, Learning Center Branch.

ARNIE-the WSO's friend

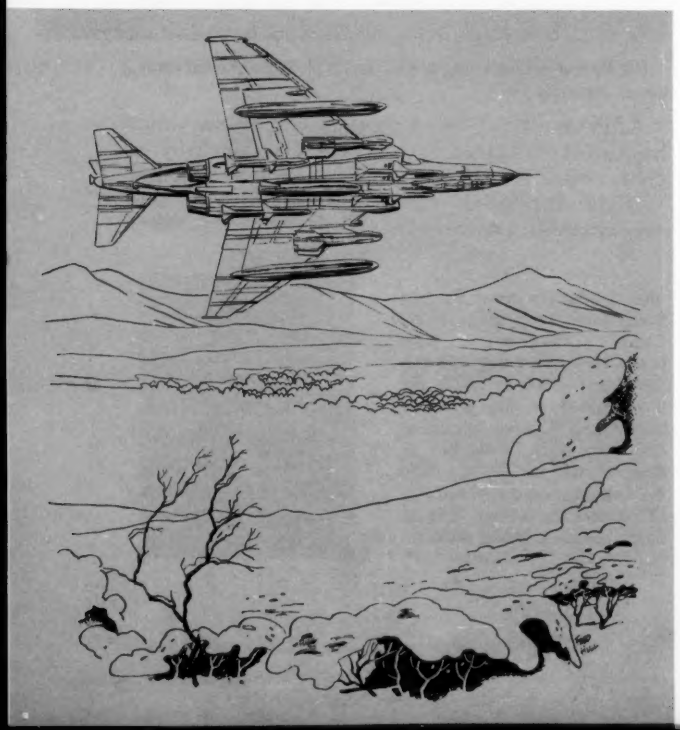
Captain Randall R. SCHMIDT
452 FTS
Mather AFB, CA

The AN/ARN-101 Digital Modular Avionics System (DMAS) is a fully-integrated navigation and weapons delivery system which drastically increases the tactical capability of the F-4E Phantom. DMAS, recently employed in the F-4E, sometimes is a phantom within the Phantom. Its capabilities are awesome, but its limitations remain since it is only as good as human inputs make it. Tomorrow's Weapon Systems Operator (WSO) will need a solid foundation of dead reckoning navigation knowledge and a better understanding of computer technology to keep this new marvel in check.

DMAS integrates Loran and inertial measurement unit accuracy for all flight phases including weapons delivery and approach to landing. "Arnie," as the system is affectionately known, is completely interfaced with all F-4E avionics and flight controls. Arnie's memory can store 54 waypoints of seven different types.

1 DESTINATION POINTS define normal navigation checkpoints such as those on a low level route. They can also define emergency airfields.

2 TARGET POINTS define specific target locations and also hold ordnance delivery parameters.



3 FREEZE POINTS, limited to ten per mission, are inserted while airborne to record aircraft position, attitude, in-flight winds or data on unexpected threat sites encountered enroute. Freeze points can also define exact destinations such as the return touchdown point on the runway.

4 AVOIDANCE POINTS define specific locations in hostile areas. These points include an avoidance radius that the airplane will circumnavigate by autopilot or that will flash a warning to the pilot if he enters the area.

5 OFFSET POINTS have several functions. They can define a no-show target by distance from the programmed point which is usually an easily recognized radar or visual feature. Offset points also can be used to update aircraft position.

6 WEAPONS IMPACT POINTS will be covered in the discussion of weapons delivery.

7 LINK POINTS have no present function but were included for future system expansion.

These various types of waypoints can be programmed in any of three coordinate systems with an accuracy of less than six feet. Normal latitude and longitude values are instantaneously converted to universal transverse mercator (UTM) or Loran time difference values and vice versa. This capability bridges a long-time communications gap between fighter aircraft and their controlling agencies. Forward Air Controllers and Advanced Tactical Operations Centers traditionally define targets in UTMs which are incompatible with older avionics systems, thus requiring a manual conversion to latitude and longitude. With Arnie, the F-4 can easily convert UTM data directly from a quick-reaction alert message.

Weapons delivery enhancement is probably Arnie's most valuable feature. Preprogrammed ballistic coefficients of 136 ordnance types can be selected to drop bombs from the three main airframe hardpoints. A three-digit identification tells Arnie what type of bombs are loaded on which stations and the computer automatically selects the required coefficients. In recent bombing competitions, Arnie's accuracy produced scores which differed in feet versus meters. Bombing delivery modes for Arnie include two categories—visual and blind.

During visual deliveries, the pilot is given a continuously computed impact point, called the

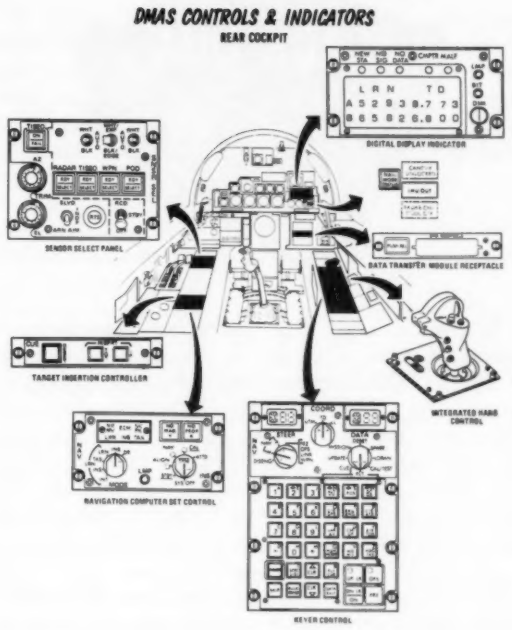
"Death Dot," to pinpoint ordnance impact. After a first impact, aircraft and crew consistency, coupled with Arnie's accuracy, allows the WSO to literally walk subsequent bombs to the target. Bombing competition winners are now decided by a crew's ability to check out the system enroute to the target and "shack" the first delivery. With the first "shack," Arnie will drop succeeding bombs in the same hole.

Using the blind mode, the WSO navigates and delivers ordnance completely by radar. With the aid of radar returns or offset aimpoints, the WSO flies the aircraft along the low level route and precisely to the ordnance delivery location while in instrument meterological conditions. During blind bombing, Arnie adjusts for winds and aircraft speed to release the ordnance on target. Blind bombing has proven just as accurate as visual bombing.

During weapons delivery, Arnie provides the WSO with a direct read-out of the front seat weapons delivery switch positions. This allows the crew to cross-check switch settings and possibly preclude a "dry" pass. At weapons release, Arnie generates a weapons impact waypoint. This point records aircraft position, attitude, target area winds, elevation, and exact weapons impact coordinates. The information can be used to aid the WSO in adjusting weapons delivery on the next pass to the target. This data on exact ordnance impact points also is very useful during intelligence debriefs. Bombing error analysis and mission debriefs are additionally enhanced by an on-board video tape recorder (VTR) which sees through a forward-looking camera as well as some types of optically-guided ordnance. The VTR records both audio and visual mission data. Radar and visual mission reproduction is invaluable to training and intelligence support.

Arnie's memory can be programmed manually during preflight or during flight planning through an interface computer. The interface computer permits loading of a programmed flight plan stored on a cassette-type data transfer module (DTM). The DTM can then be carried to the jet for instant data transfer to the on-board computer.

Some have theorized that, with proper programming and something to hold the pickle button down, the crew could eject over friendly territory and Arnie would fly at low altitude, avoiding programmed enemy defenses (avoidance points) to deliver the ordnance on a selected target. After "bombs away," Arnie would then fly the jet home and descend to a designated



touchdown point on the runway. Since Arnie can't control the throttles, precomputed fuel starvation would flame the engines out upon touchdown.

Arnie's capabilities are tremendously enhanced through proper flight planning, programming, and airborne execution. Especially important is the WSO's understanding of where and how Arnie is navigating. Each leg of a mission requires cross-check of basic DR against Arnie's distance and heading to the next point. Incorporated with sound aircrew DR, Arnie can speed the time required for basic tasks, thus allowing a WSO more time to "check six" and defend against upcoming threats. Arnie provides tremendous potential for precise navigation and ordnance delivery, but like any computer system, he is only as good as the basic DR and avionics knowledge backing him up.

A graduate of Park College in Missouri, Capt Schmidt entered the Air Force via OTS. In 1979, he completed UNT and was then assigned to the F-4 in Korea, followed by Seymour Johnson AFB. Capt Schmidt is an instructor with the 452 FTS.

THE BLACK BOX

Editor's Note: The following anecdote is reprinted from Volume XI, Number 1, of THE NAVIGATOR (Summer 1963). Written by then Lt Joseph A. Rice, 3607th Navigator Training Squadron, Ellington AFB, Texas, we include it as an introduction to Capt Brown's article "Inside the Black Box." The more things change, the more they remain the same. Former Lt Rice, if you should read this, we'd like to hear from you.

There is a story of an old Air Force Navigator who grew hoary-headed and bowed with years in the service and was never known to make a mistake.

You have all heard of him. He was one of the first men to navigate from the mainland to a Pacific atoll. He flew B-24 and B-17 bombers during World War II. The many missions he guided were models of efficiency and accuracy. He pinpointed B-29s to their targets through cloudy Korean skies and, in the latter stages of his career, he led great jet bombers halfway around the world and estimated his time of arrival within less than thirty seconds.

He was revered and emulated by all aspiring navigators. They patterned their work methods after his and many grew bushy mustaches like the one he had. In time, the influence of this man was felt throughout the entire Air Force. Legends surrounded his name and gave a supernatural aura to his deeds, obscuring the fact that, though a remarkable navigator, he was, after all, only human.

Many people said he had a God-given talent. Astrologers claimed that he was born in the ascendency of a lucky star. But most practicing navigators agreed that the secret of his success could be found in a black metal box which was at his side every moment he was in the air. Many times he had been seen opening the box and looking inside as soon as he was airborne.

Many times he was asked to reveal the contents of the Black Box. But he always replied with a quiet shake of the head. For years people badgered him to tell his secret. But he never wavered in his inner decision to keep it to himself until, the year before his thirty years were up, an exceptionally personable young navigator persuaded him to pass the black box on to him upon retirement.

The Air Force seemed to hold its breath as the months slowly ticked by. The day finally arrived and a crowd of several hundred flying officers was on hand as the young man, with trembling hand, inserted the key into the lock of the Black Box, opened it carefully, and drew from it a paper on which was printed the following: "East is least, West is best."

INSIDE THE BLACK BOX

Captain Gregg L. BROWN
449 FTS
Mather AFB, CA

As you fly through the night watching the INS blink the aircraft's position, or the SRAM indicate your exact heading below the cloud deck, or the ADU find an impossible release point, have you ever wondered exactly how that magic works. After successfully completing a mission, have you ever requested such an explanation, only to be frustrated by replies like, "You don't need to know." "Just press the buttons and forget all that technical stuff." "Don't worry about it, it's being

replaced anyway." Or even the extremely rare, "I don't know." This article will help you understand computer equipment without intimidation or insult. It is not written for engineers or technicians. In fact, the technical types among you will find literary license used to aid understanding, at some expense to technical accuracy.

All computer systems have common characteristics and components. We'll focus on those characteristics by examining a hypothetical computer system with universal application. Avionics computers are not unique but, with a little solder and other tie-in changes, could be converted to word processors, microwave oven controllers, stop-light sequencers, or home video games. Their simple operation is basically the same. Understanding them starts with the concepts of "hardware," "software," and "firmware"–terms we hear more frequently as new computerized avionics systems come on line. We often confuse how these terms relate to each other.

The question, "Which came first, the chicken or the egg?" illustrates the operational relationship of hardware and software. Hardware includes physical system components—things you can look at, touch, and show off during an open house. On an Air Force base, hardware is the runways, hangers, office buildings, roads, and houses. These facilities by themselves, however, are inert and useless. Like the Air Force base, computer hardware constitutes the "facilities" upon which to build a system. As a base's facilities limit its capabilities, computers are limited by their memory addresses, access points, and operator controls. Still, this hardware alone is like an abandoned base with excellent facilities but without people or goals.

To make a base useful, someone must define the mission. A computer's application or "mission" must also be defined. A base's mission options could be fighter, bomber, transport, training, or a combination. A computer might be designed for navigation positioning, bombing, reconnaissance or innumerable other applications. In either case, the purpose will shape the policies, procedures, and instructions written to meet it. With the purpose defined, these programs can be developed and general policies written. For each program facet, operating instructions are developed. These instructions equate to computer "software." Software is the set of instructions to which the hardware responds.

With an understanding of the relationship between hardware and software, let's examine the hardware components of a computer system. Using our hypothetical Air Force base example, we'll start with the headquarters section. The headquarters receives commands from off base to direct the mission. Based on the instruction, headquarters then decides where to send and from where to request information required to carry it out. In this way, the headquarters acts as an information processor. Computers also need processors to receive and distribute information in response to external commands. The single-chip microprocesser serves that purpose. Several types of single-chip microprocessors are available, with slight technical differences. They are identified by type number such as 6502, z80, 8080, 6800, etc. The type of microprocessor employed establishes the kind of computer system we build. A choice of the 6502 microprocessor typifies our system as a 6502-based computer system. We could have chosen any of the others with no major change in function.

Computer enthusiasts would be disappointed if I failed to say that the common term for a coordinating or processing device is Central Processing Unit (CPU). It could be a micro, mini, or macro unit depending on anticipated system demands. We will anticipate few demands, so an eight-bit microprocesser is sufficient. Incidentally, this is the same CPU used in the Atari, Apple, and Commodore home computer systems.

Explaining the intricacies of the 6502 can be a long and detailed process. For us, it is enough to know that a CPU must be able to receive and transmit internal and external instructions. It receives or transmits three types of information at once: control, address, and data. To keep the correct control signal together with its

appropriate address and data, a timing mechanism is needed. It sequences information by allowing only one set of information (control, address, or data) to go into or out of the CPU at one time. As each set of information is handled, the next set can be processed. This timing function is similar to the service of a control tower operator. As the controller sequences arriving and/or departing aircraft on one runway, the computer timer sequences arriving and/or departing information on one CPU.

The next step in building our system is to tie a communications network to the CPU. For each of our three types of information, we need a separate communications channel. We call these channels buses. Specifically, we need a control bus, an address bus, and a data bus. A three-channel (three bus) communication is similar to a control tower instruction. The tower transmits: "BUFF 01, HOLD SHORT OF RUNWAY 22 RIGHT." Broken down, this message has a signal on the address bus of "BUFF 01," a signal on the control bus of "HOLD SHORT," and a signal on the data bus of "RUNWAY 22 RIGHT." You may wonder why an address bus is necessary. Addresses relate to the hardware component called the memory which we'll discuss later. For now, think of the memory as a set of address locations for information storage or retrieval directed through the CPU.

A control bus carries many signals. A memory-enable signal brings the memory on-line to interact with the data and address buses. With the memory enabled, the CPU can read from or write to the memory (receive or transmit). The type of action depends upon the type of read/write signal on the control bus. The control bus is sequenced by the CPU in response to the timing mechanism. Before the control bus can accept signals for later communications, a ready signal on the bus must terminate functions of a communication in progress. The timer insures adequate time to complete each communication before the bus is cleared by the ready signal. The pulse that clears the control bus also clears the address and data buses within the CPU.

Address and data buses work together to insure that the computer has correct information for each communication. The address bus tells the memory the "location of interest" and the data bus carries information to be stored or retrieved at that location. Data buses consist of a set of lines, each of which has two states, on or off. Usually, this area of computer talk intimidates most beginners since it is where the concept of binary or base-two representation is introduced. Information on a data bus can best be related in terms of a binary number. You need not be a math genius to understand the data bus. Discussing methods to convert base ten or decimal numbers to binary is unnecessary. Navigators do so all the time with base ten to base 60 conversions of time, distance, speed, and so forth. We only need realize that any number has one specific value no matter what format or base we choose to illustrate that value. If the technology existed to use ten separate conditions for each line on a data bus, we could represent a piece of information (data) as a base ten number with each line representing one digit. Thus, a three-line data bus would represent the values 000 through 999, or 1,000 different pieces of information. A two-line data bus would represent values from 00 through 99, or 100 different pieces of information. The familiar decimal system does not apply to computer capability. Computers use the binary system, where each data line has only two states, on or off. Turning data lines on and off, in different combinations, produces an electrical representation of a binary number. The range of binary numbers represented depends upon the number of lines on the data bus. Figuring a binary system's capacity is relatively simple and will help explain those unusual numbers computer experts use. However, some math theory is necessary at this point.

Our previous base-ten example will help with this explanation. A two-line bus can handle 100 different values. Using base ten, this equals ten squared or ten to the second power. A three-line data bus can handle 1,000 different values—ten cubed or ten to the third. The number of data lines specifies the number of digits available. The number of digits available specifies the exponent of the base we use. A hand-held calculator with an exponent function can help you understand this relationship. The same principle works with binary and decimal systems. A two-line binary bus can carry two (binary base) to the second (number of data lines) number of values.

The 6502 microprocessor uses an eight-line data bus with ample capability for our purposes. This gives us 2 (binary base) to the eighth (eight data lines) values for bus capacity. On the eight-line bus, each line is called a "bit" of information. The value represented by all eight bits at one time, (the data bus value) is called a byte of information. Besides number values, letters and words are each represented as a byte of a certain coded numerical value. The standard code for assigning values to typewriter keyboard characters is the American Standard Code for

Information Interchange (ASCII), pronounced "askey."

So far, our system includes the following hardware: a 6502 microprocesser (CPU); a control bus with read/write, memory enable, and ready lines; an address bus to specify memory locations of interest to the CPU; and a data bus with eight lines to carry up to 256 (two to the eighth power) different values, one value at a time, between the memory address and the CPU. Also, we have a set of storage locations whose collective addresses we refer to as the memory.

With that discussion of how the buses work, we can examine the memory more closely. Again, the memory is a collection of storage locations, each with a specific address. Each location is identified by the address bus and can do one of two things, as dictated by the control bus. The memory can be read and its value sent by the data bus to the CPU, or the memory can copy signals sent by the CPU. Both the memory locations and the CPU registers have eight tiny switches, each with an on or off mode. While reading from the memory, the data bus lines are fed current from the "on" switch positions and no current from the "off" positions. In this manner, the value in the addressed location is copied by the eight lines of the data bus as a binary value. The active control bus read signal opens an internal register in the CPU to copy this value from the data lines. Once the CPU receives the information, the communication is complete and the timing mechanism will pulse for the next cycle. This clears the buses for the next communication dictated by the software. The write command works in reverse of the read command. To write, the data bus is cleared so it can copy the value in the CPU internal register. Once this value is on the data bus as an eight-digit binary value, the control bus write signal allows the memory location, specified by the address bus, to set its respective switches in order to copy the data bus value. The timer sequences this and fires the next cycle. The most popular memory device today is the 2K memory chip. Several companies manufacture these memory chips which are mostly interchangeable. One or more of these chips provide computer memory capability.

The two basic types of memory chips, known as ROM and RAM, are distinguishable by their different capabilities. ROM is an acronym for "Read Only Memory." ROM chips will not accept a write signal. The CPU can read their contents but cannot change them since the contents are permanently imprinted when manufactured. ROM is, in fact, not accessible to the operator. Since the ROM is permanent, it is retained when the computer is turned off. Besides providing information storage, different language interpreters and/or compilers are stored in the ROM, such as BASIC, COBAL, FORTRAN, etc. Many avionics computer systems have a memory consisting almost entirely of ROM because it keeps the operator "out of the system." ROM is referred to as firmware because it provides software instructions in a permanent hardware form.

The other type of memory, RAM, stands for "Random Accessible Memory." RAM is, as the name implies, accessible to the operator. When you update stored coordinates in your INS, SRAM, or NCS, you are working with RAM. RAM chips will accept and respond to control-bus read and write signals. RAM's drawback is that its contents usually "dump" when power is removed. RAM is classified as either dynamic or static. Dynamic RAM requires a refresher pulse with each machine cycle to keep its contents intact. Static RAM requires only system power to maintain its contents. System designers resolve these differences for us so RAM operation is the same regardless of type.

A memory must be large enough to hold the instructions we want the machine to execute, along with operator or automatic input/outputs. We call the constant set of instructions the "program," and the variable input/outputs the "data." The combination of program and data is what we already know as software. You may wonder how software is inserted into the memory in the first place. In the case of ROM, it is manufactured along with the chip. As for RAM, the operator must somehow load the memory. This communication, outside of the system, requires an external device.

Many different types of external devices interface with computers. We'll discuss them in terms of function. Some devices are strictly for sending information to the microprocessor and others for displaying values from the

microprocessor. The keyboard and thumbwheel are popular input devices. With thumbwheels, we first preset a value which may be in the base 60 format of latitude/longitude, the base-ten format of speed/distance/altitude, or some other combination. Whatever format the wheels accept, the value is mechanically preset in an eight-digit binary code. Once the value is set, we must instruct the microprocessor to read the thumbwheels. This is done by a signal on the control bus called the interrupt signal. This interrupt occurs when a transmit switch closes on the input device and sends the value to the CPU input/output (I/O) port. A transmit switch may take on many shapes, sizes, and colors on different equipment. It may be a red button labeled EXECUTE, a square button labeled STORE, a lighted button labeled RADAR FIX, or a typewriter key labeled RETURN/ENTER. In all cases, the transmit switch interrupts the CPU to send preset values to the CPU's I/O port. When the I/O port receives the information, the software uses it. Other types of input devices differ mainly in the ease and speed with which values can be preset and sent. Up to now, we have discussed inputs from the operator only. Some systems accept inputs from other systems.

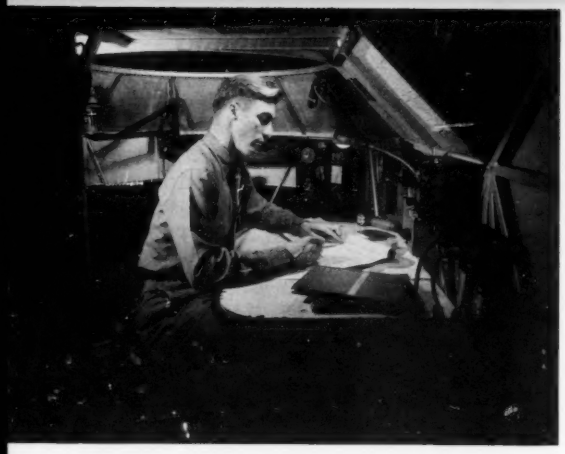
Other computer input information might include true air speed, Doppler, heading, altitude, fuel, or temperature. If we don't wish to manually load this information repeatedly, we can connect the signal to another CPU input port and program the software to automatically interrupt and read the signal. If the signal is analog, in the form of voltage rather than a digital number value, it is simply sent through an analog to digital converter. This is how bombing computers accept tracking handle inputs for aiming the crosshairs. Such a system is referred to as automatic input. It can occasionally be disabled to permit manual insertion of information through the operator control. Devices described, thus far, can load one piece of information at a time. Other devices are able to mass-load many pieces of data. This capability is often referred to as external storage or memory.

As we have seen, a great deal of software already may be stored as ROM. Information which changes daily, such as mission data, cannot be built into the ROM. It must be loaded into the RAM. To make things easier, we can store such data externally on any of several popular mediums. One way we can rapidly feed an entire set of data to the RAM is by using a punched-hole or magnetic tape. The magnetic tape uses audio-type beeps to represent binary values. Another system, disk storage, is a very flexible system which stores data magnetically on a coated disk. The disks have different tracks like a phonograph record, and each track has several sectors which can be accessed at ramdom. The random accessibility of the disk is far superior to the serial-loading tapes. This random accessibility advantage is available in the punch medium in the form of punched cards.

So far, we have discussed an internal system made up of a CPU, buses, and memory. We can input information to the system from various mass or individual input devices through CPU I/O ports. However, before we have a working system we need some way to get usable computer data from it. We do this with, you guessed it, output devices. The most popular output device for common computers is the cathod-ray tube (CRT) screen. Another option, the printer, produces hard copy of computer outputs but it is relatively slow, more expensive, and very noisy. Some airborne aviation computers are now using CRTs as output devices, but wide use is not yet a reality. Another type of device for displaying output information is the numerical display. It uses light emitting diodes (LED) or an analog display of painted number wheels to show digital values. Just as there are sources of input besides the operator, there are also other output ports which can be automatically controlled by the software. These non-operator outputs could be autopilot controls, fuel values, present position displays, dead reckoning information, time, cross track, etc. On many systems, a storage outlet is used to save information in the internal memory.

The choice of input/output devices is the variable with greatest impact on computer system operation. Software can be easily modified and internal memory can be expanded with relative simplicity. I/O devices are expensive and subsequent expansion of their capabilities is often more costly than system replacement. With the addition of I/O devices, we have all the hardware needed for a complete system. The only things left to do are to connect it to a power supply, load the software, and start "compunavigating" with the confidence of knowing what's going on inside the black box.

Capt Brown graduated from Embry-Riddle Aeronautical University in 1972 with a degree in Aeronautical Science. After OTS, he completed UNT and NBT in 1974. He then served in the B-52H at Grand Forks AFB. Since 1979, Capt Brown has been an instructor with the 449 FTS, Mather AFB.



NAVIGATION -a proud heritage

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Today's military navigator—the position-finder, radar operator, weapon systems officer—originated with World War II, at least in the US Army Air Forces (AAF). Prior to that time, overwater navigation (the only kind then requiring a full-time navigator) was the exclusive domain of the airlines. The first long-range airliners were "flying boats." Their navigators had no long distance radio nav aids, such as LORAN or Omega. Celestial and DR were their stock in trade. As the 1940s approached, aviators realized a navigator was necessary on transcontinental bombers and transports. Up to that time, navigational duties had been performed by pilots as a second duty. Military aircraft were still relatively short-ranged.

The first course of study for AAF navigators was conducted in 1941 by Pan American Airlines at Coral Gables, Florida. Students from those first classes formed the cadre of the thousands of World War II navigators who followed. The Pan American program laid the groundwork for our present day navigation techniques, ideas, and equipment. In 1941, navigational equipment was minimal. The airline course stressed the very basics: DR, celestial, use of the driftmeter and map reading. Doppler, inertial, radar, and position computers were unheard of then. The AAF navigator training program began expanding rapidly and the new navigators found themselves truly learning by doing.

Those early days were extremely interesting and challenging. New equipment, training aircraft, and techniques were continuously being adopted. The stress of war brought forth an unprecedented leap in science and technology which tremendously enhanced the science of navigation. As an example of just how fast things moved in wartime, consider this: at the beginning of the WWII, navigation was strictly DR, aided by celestial and map reading, as previously mentioned. By the war's end, radar and LORAN had been developed and were operational, an airborne computer was operational, the first experimental Doppler system was undergoing tests, and pressure pattern navigation had been honed to a fine art. Also, VOR and DME were functioning, as well as several navigation-

bombing systems (SHORAN and DECCA). Radar-directed bombing was done routinely by B-17s and B-29s, and work was underway on the first inertial systems. Quite a few technological leaps in just four years.

Let's take a look at some specific early aircraft and missions to see what our WWII counterparts faced. One of the most famous aircraft of that time was the B-17 Flying Fortress—star of "12 O'Clock High" and actor in thousands of sorties over Europe. The '17 nav had little to work with in the beginning: a chart, driftmeter, ADF, sextant, and compass. Most navigation and bombing relied upon visual methods (map reading), although some lead aircraft were equipped with the APS-13 radar system for "blind" bombing and navigation. Cruising at about 150 knots and 20,000 to 30,000 feet, the B-17 navigator had plenty of time to map read and check drift, but at those speeds and altitudes his aircraft was very vulnerable to ground fire and fighter attack. Nevertheless, most large formations were right on the money with time over target, and thousands of navigators received praise for their achievements, under extremely adverse circumstances. (Two B-17 navs won the Medal of Honor.) In addition to navigational duties, the B-17 navigator swung a 50 caliber gun when the occasion demanded.

In tactical aircraft, the B-25 and B-26, both medium bombers, carried a navigator on the crew. Most of their missions were flown between 5,000 and 10,000 feet with navigation strictly by map reading. The nav worked in close harmony with the bombardier and, over the target, the bombardier took charge. He steered the aircraft through inputs to the bombsight. This required straight and level flight during the bomb run. No evasive action could be taken.

Often, in both strategic and tactical formation operations, some aircraft had no navigator or bombardier assigned. Many times the entire formation followed the lead to the target, released their bombs on his signal, and followed him home. Considering the experience level of the crews (many navs had less than 300 hours total time) and the unpredictable weather and primitive equipment, the WWII navigator did an amazingly good job. Mistakes occurred, however. During the Polesti raid by B-24s, the lead aircraft turned short at the wrong IP, causing the formation to cross the target at the wrong time and on the wrong heading. Unfortunately, a second formation was over the target at the same time and the resulting meelee was catastrophic.

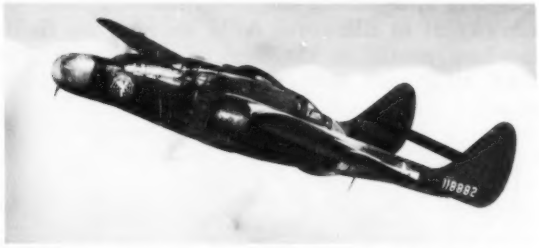
The techniques, procedures and equipment of the B-17s, 24s, 25s, and 26s were continually improved and, by the time the B-29 was ready for use in the Pacific, navigation had progressed as much as in the preceding 20 years. The B-29s routinely flew 3,000 mile round trips entirely over water from Guam to Japan. The first LORAN chain was set up in the Far East, and pressure pattern (made possible by the introduction of the radio altimeter) was highly perfected. Radar was also used for navigation and bombing with the first GCA unit installed by the AAF on Iwo Jima soon after the island's capture. Toward the closing days of the war, many B-29s were equipped with radar homing and warning gear, and an Electronic Countermeasures operator had become part of the crew—the forerunner of today's EWO. The B-29 "Enola Gay," which dropped the first atomic bomb, had a countermeasures operator aboard. The B-29 crews went on to become the nucleus of post-war SAC. A direct line can be traced from those WWII bombing missions to the role of today's modern bombers, including the B-1.

The famous "Flying Fortress"—Boeing's B-17 could withstand severe damage and keep flying.

North American's B-25 "Mitchell" bomber flew the first Tokyo raid.

A WW-II B-26 formation over Europe.

Regarding fighter operations, the WWII fighter was primarily a single-seat design. P-51s, 47s and 38s were used in all theaters, with much success. The one notable exception to this, however, was the P-61 Black Widow—the first fighter specifically designed as an all-weather, day/night inteceptor. An integral member of its crew was the radar operator, the forerunner of today's WSO. The P-61 had a primitive, but effective, airborne radar. The aircraft proved to be a very successful air-to-air weapon. Used both in Europe and the East, the P-61 quickly proved the concept of a multi-place fighter with a dedicated systems operator. It could identify, track and destroy enemy aircraft in any weather and at night. In fact, most of the P-61's victims never saw what hit them. The radar observer acquired the hostile aircraft on the airborne set and vectored the pilot in for the kill. Today's F-4 and F-111 WSOs can trace their heritage directly back to the P-61.



Northrop's P-61 "Black Widow"—The first American-designed night fighter with radar guidance.

In the transport world, the C-47s, C-54s and C-46s of WWII did just what their counterparts do today—deliver anything, anywhere, anytime, and in any weather. This was and is the domain of the traditional long distance navigator—where the plotters, sextant and dividers get a workout. As previously mentioned, overwater navigation was strictly DR aided by celestial at the beginning of WWII and remained much the same throughout. Radar, computers, and the other fancy things commonly were installed in bombers and fighters long before transports. Still, transport navs usually got where they were going. Charts were a problem since some areas of the world were still poorly mapped. More than one cargo navigator used charts supplied by the National Geographic Society!

Now, this may be a fine history lesson, but what's the point of it, you may ask yourself. The answer is simple. As navigators, we have a fine heritage, one that we can be extremely proud of. Many have gone before us and blazed the trail. We can take comfort and pride in knowing about our heritage.

The much-revered Douglas C-47 "Skytrain"—Better known to many as the "Gooney Bird."

The Curtiss C-46 "Commando" earned fame from dangerous flights over the Himalayas to China.

If you are a C-130 nav enroute to Europe, over water, with the stars as your guide, just think of the souls who flew the same route 40 years before with handheld sextants and a prayer. To sight the stars, they climbed over passengers and cargo all the way to the back of the aircraft and shot through the lavatory window. Drift, groundspeed and wind were often optimistic guesses—but they made it! If you fly F-4s, your forerunners flew in noisy, uncomfortable P-61s, bending over a temperamental, vacuum-type radar, straining to make out targets at only five miles range. Their Pacific bases were on blacked-out islands with no operating aids of any kind. Getting home was quite a trick. You bomber folks can just imagine map reading to a target and back, dodging flak and fighters in a B-17 or B-24, and leading perhaps 300 other airplanes in the formation.

Yes, our history is unique and interesting, but now we are building a heritage for the navigators of the future. You may not think it's all that important but, 30 years from now, navigators of the 21st century will look back at the primitive F-4s, C-130s, and B-52s of this day and say, "I wonder how they did it back then with only INS, Doppler, Omega, etc!

Capt Woodruff graduated from North Carolina State in 1972. After completing UNT in 1973, he served in the C-130 at Little Rock AFB until 1978 when reassigned to Mather AFB. From May 1980 until May 1982, he was Editor of THE NAVIGATOR magazine. Capt Woodruff now is a C-130 instructor at Little Rock AFB.

THE DNS MONITORED LOCALIZER APPROACH

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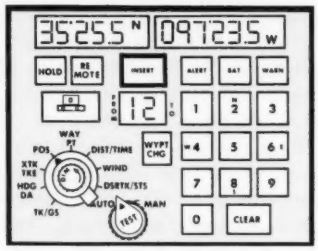
With the advent of higher technology at a lower price, commercial and general aviation area navigation systems are now quite popular. These systems, also known as the "poor man's INS," serve not only for point-to-point navigation while in range of a VOR/DME, but also for non-precision instrument approaches where radio reception and propagation tolerances can be met.

With the installation of inertial (INS) and microwave Doppler navigation systems (DNS) in the Boeing C-135 series aircraft, we can take advantage of an RNAV-like function during tacan-aided (TACMIX) operation. The DNS accepts this tacan updating function to a greater degree than the INS, so this article will address DNS monitoring for localizer or ILS approaches.

The TACMIX mode of operation will, through the magic of computerization, convert radial coordinate information (radial-DME) to cartesian coordinates (latitude and longitude). It then becomes the navigator's task to convert DNS data into useful approach information. This is where the orbital pattern steering (OPS) function applies.



In Fig 1, depicting the ILS/DME approach to runway 31 at Ellsworth AFB, we note the final localizer course to be 305° magnetic, with the FAF, VDP, and MAP defined off from the RCA tacan.

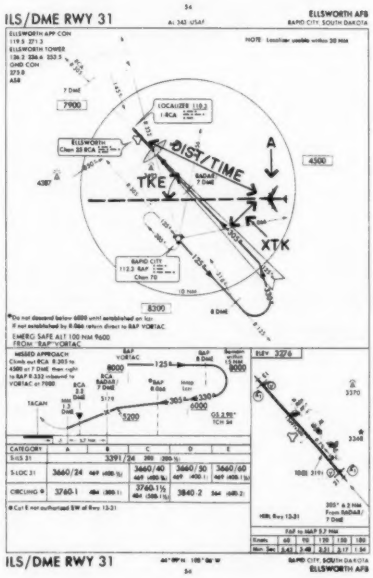


Figure 1

The navigator loads RCA tacan information to the closest 0.1 minute of arc. In this case, it is 44 08.4'N, 103 06.1'W (see Fig 2). Since the tacan is not located on a convenient 0.1' of latitude, we will load coordinates for point A', some 200 feet north of the tacan. Tacan elevation and frequency are

obtained from the approach plate, IFR supplement, or applicable charts. Information from a "data summary sheet," released by SAC and compiled from Federal Aviation Administration current information, should be used for establishing tacan slaved variation. Slaved variation most likely will not coincide with actual variation. The slaved variation for the RCA tacan is 13° east while the actual 1982 variation is only 11.1° east. Next, latitude and longitude coordinates for point B are loaded into a waypoint register. Point B′, which is the same distance north of B as A′ is from A, now becomes the actual point to which the aircraft will fly. This reference point is located on runway centerline, abeam the tacan facility providing distance information for this TERP.

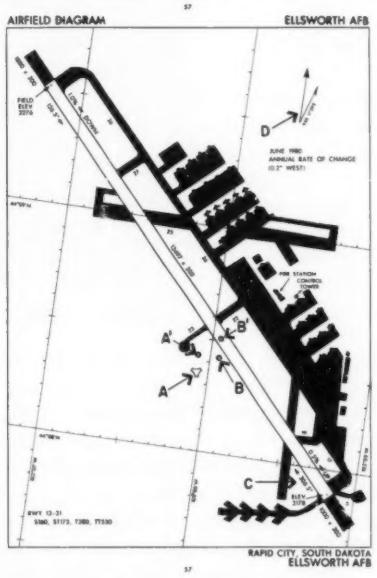


Figure 2

You can now load localizer information using the runway azimuth (Fig 2, pt. C) and field magnetic variation (Fig 2, pt. D). These calculations yield the following information: 306.5° mag az. + 11.5° east magnetic variation = 318.0° true azimuth. (Note: Variation and azimuth are both June 1980 values, and although both change from year to year, they always equal 318° true. True azimuth can now be loaded as 318000 into the right-hand display of the RNG/BRG function on the DNS Control Display Unit (CDU).

While on a base leg or a dogleg to intercept the final approach course, set the runway centerline waypoint in the TO side of the FROM-TO display and select the orbital pattern steering function 00. Setting the AUTO/MAN switch to MAN will prevent bogus "backside-orbit" information from being displayed on the CDU during a missed approach.

With your DNS so configured, the DIST/TIME function will display "DME" to the runway point selected (distance values will coincide with FAF, VDP & MAP values on the TERP) and the XTK/TKE will show distance, in miles and tenths of miles, right or left of the localizer (See Fig 1, pt. A). This information can help your pilot during vectors to an ILS approach, since no bearing information is available to show offset right or left of the localizer. Localizer course guidance is generated from a very narrow energy beam, usually 3° wide. The course deviation indicator will not engage itself, even at 12 to 15 miles from the localizer antenna, until the aircraft is within a few thousand feet of the approach course. When on a 90° base leg at 180 KIAS, your turn radius could be larger than the localizer sensitivity range, thus causing the aircraft to overshoot the final approach course. It should be RAPCON's responsibility to direct you on an acceptable intercept angle (30–45°); however, with heavy workloads and controller trainees, the DNS assures a good crosscheck. You can orient yourself with respect to the localizer approach course and accurately follow all stages of the approach.

When the OPS function is inserted into the DNS on a downwind leg, the DNS may select the "backside orbit" heading and an offset of 9 nm from the actual inbound localizer course. In such a case, the 5-5 orbit function can be used with the AUTO/MAN switch in manual. This will present the proper course and azimuth.

As professional aviators, we can't do too much to insure the safe outcome of any flight mission. Your DNS can give that extra margin of safety to see you through.

A 1974 graduate of the University of Colorado at Boulder, Capt Smith first was assigned to the Defense Mapping Agency, Warren AFB. After UNT and CCTS, he served as a KC-135 navigator. Capt Smith is now an instructor at Ellsworth AFB.

Professional Recognition

Editor's Note: Professional Recognition is a new feature in THE NAVIGATOR. Its purpose is to acknowledge outstanding performance, individual achievement, and other endeavors that contribute to the navigator and officer professions. If you know fliers whose extra professional effort distinguishes them, send us a brief description of their accomplishments and we'll give them professional recognition.

CAPTAIN
STEPHEN S. WHITSON

We are proud to recognize Captain Stephen S. Whitson as the 1982 recipient of the Institute of Navigation's Superior Achievement Award. The award is presented in recognition of outstanding performance by a practicing navigator. Captain Whitson earned the honor for his key role in a life-saving rescue on 12 December 1980, near Johnstone Point, Alaska.

On that date, Captain Whitson's unit, the 71st Aerospace Rescue and Recovery Squadron, Elemendorf AFB, was called to the aid of a light aircraft, forced down onto sea ice during a whiteout. The light plane's pilot and passenger were unhurt in the landing but were stranded on the ice in 40 knot winds with a chill factor of minus 60 degrees Fahrenheit.

The 71st dispatched an HC-130 and HH-3 rescue aircraft to pick up the stranded fliers. When deteriorating weather threatened to force the HH-3 back to Elemendorf, Captain Whitson used his HC-130 navigation equipment and station-keeping procedures to lead the helicopter to the distressed plane.

Overcoming a radar malfunction, he improvised a radar-directed approach to guide the HH-3 between 3000 to 4000-foot mountains while IMC. With the rescued fliers safely aboard the chopper, Captain Whitson carefully guided the flight to an airfield at Cordova, Alaska. Failure of navigation aids,during the helicopter's approach, again required Captain Whitson to direct the HH-3 to a safe landing.

Captain Steve Whitson's professional skill saved the two stranded fliers and contributed directly to the safe recovery of the HH-3 and its crew. THE NAVIGATOR salutes Captain Whitson for a job well-done.

CAPTAIN
ELLEN C. ERNST

Captain Ellen C. Ernst won the Air Force Association's Maj Gen A.M. Minton writing award for her article, "Readiness: A Bird's Eye View" which was published in the Summer 1981 issue of the Air Force Engineering and Services Quarterly.

Presently serving as a KC-135 navigator with the 407th Air Refueling Squadron, Loring AFB, Maine, Captain Ernst was a civil engineer at McChord AFB when selected for navigator training. Her engineering service with a McChord Prime Beef squadron provided the experience and perspective for her winning article.

Although Capt Ernst has been serving as an operational navigator for just one year, she has kept busy with squadron duties. Since her assignment to the 407th AREFS, she revised the squadron Navigator's In-flight Information library and acted as Tanker Operations Officer during the unit's participation in Bold Eagle '82.

Captain Ernst earned her bachelor's degree in architecture from Carnegie-Mellon University. She was commissioned through OTS in August, 1977 and is a member of the Society of American Military Engineers.

an ARCTIC DILEMMA

Captain William J. KASSON
323 FTW/DOVN
Mather AFB, CA

It was a cold and dreary night when Claude Naud, better known around Chibougamau as Nanook Rothschild of the North, got a disturbing phone call. The plane carrying his daily ration of vintage French wine was forced off course by a vicious storm and was now overdue. He quickly deduced that the plane had either crashed or force landed somewhere in the arctic wilderness. In the twinkling of an eye, Claude was dressed and mushing his dogsled on in search of the downed plane. While departing, he was heard muttering, "I must hurry. Chateau Laffitte could lose its delicate balance and complexity if too chilled." A short time later he discovered that his Cub Scout compass was unreliable. He was now hopelessly lost, but luck would be with him.

As dawn broke several weeks later, Claude spotted something unusual in the blowing snow. Closer inspection revealed the frozen body of a bush pilot with a piece of paper clenched in his hand. On the paper was the following message:

5 JULY 1968
I GOT THREE CELESTIAL OBSERVATIONS THROUGH HOLES IN THE CLOUDS YESTERDAY, BETWEEN ATTACKS FROM A VICIOUS POLAR BEAR. I BASHED HIM ON THE HEAD WITH MY SEXTANT SO THE READINGS MAY NOT BE TOO ACCURATE. UNFORTUNATELY, BEFORE SUBDUING HIM, HE ATE MY AIR ALMANAC AND NOW I DON'T KNOW WHAT TO DO. SURE WISH I HAD A GOOD NAVIGATOR HERE TO HELP ME FIGURE OUT THIS FIX. HERE ARE MY READINGS.
TIME (Z) HO
0100 22-36
0930 13-37
1756:21 37-38

Claude quickly pulled his HO 249 volumes from under his seat, where he kept them so he could see over the sled dogs, and resolved the three shots to a fix. Where was he, what was the sextant error, and what heading did he mush to get back home?

A 1972 USAF Academy graduate, Capt Kasson obtained his master's degree in Business Administration through AFIT from the University of California, Los Angeles in 1973. After UNT, he was assigned to Clark AB in the C-130E. Since 1979, Capt Kasson has served at Mather AFB, presently with Stan Eval.

Mail your answer to:

Editor, THE NAVIGATOR Magazine
323 FTW/PS
Mather AFB, CA 95655

Editor's Note: On 1 February 1983, we will randomly draw two names from those submitting correct answers. The two lucky winners will receive handsome pen and pencil sets.

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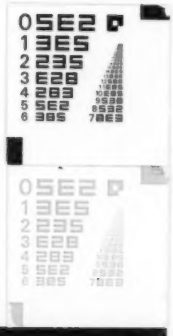
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